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AUTHOR	Shaffer, Clifford A.
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ABSTRACT

This report describes a multidisciplinary project by members of Virginia Polytechnic Institute and State University's Departments of Geography and Computer Science, and College of Education, to develop computer-aided education software for introductory geography at the college and high school levels. GeoSim's goal was to produce major changes in undergraduate geography education by applying the capabilities of Geographic Information Systems (GIS) and simulation. The goal was to improve geography education through the use of interactive educational software. A series of five computerized laboratory modules applicable to virtually all introductory geography courses were created: Intlpop/Rumpop--teaches the basics of demographics and population modeling; MigModel--used to study modeling of migration patterns between counties of the United States; Mental Maps--a test of knowledge regarding the location and other attributes for cities; Migration and Political Power--simulates the effects of immigration and between-state migration in the United States; and Sense of Place--used to investigate a large database of information about the counties of the United States The modules are highly interactive, appropriate for computer novices, and are able to run on a wide range of moderately priced equipment. An additional part of the project goal investigated the feasibility of disseminating courseware via the Internet. Appendices include descriptions of the tutorials and simulations, a sample exercise and questionnaire in the GeoSim evaluation, and a brochure describing the Project GeoSim. An executive summary is provided. (SWC)

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Project GeoSim

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Department of Computer Science and
Department of Geography
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061

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P116B20130

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Project Director:
Clifford A. Shaffer
Department of Computer Science
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Telephone: 540-231-4354
Email: shaffer@cs.vt.edu

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1 Summary

Project GeoSim is a multidisciplinary effort by members of Virginia Tech's Departments of Geography and Computer Science, and College of Education, to develop computer-aided education software for introductory geography at the college and high school levels. **GeoSim**'s goal is to produce major changes in undergraduate geography education by applying the immense capabilities of Geographic Information Systems (GIS) and simulation. By adding significant geographic analysis to the initial course in the major, one which enrolls over 425,000 students annually nationwide, the effects of this project will be wide spread. We have created a series of computerized laboratory modules applicable to virtually all introductory geography courses. These modules are highly-interactive, are appropriate for computer novices and are able to run on a wide range of moderately priced equipment.

Project Director:
Clifford A. Shaffer
Department of Computer Science
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Telephone: 540-231-4354
Email: shaffer@cs.vt.edu

Principal Investigators:
Lawrence W. Carstensen, Department of Geography
Robert W. Morrill, Department of Geography
Edward A. Fox, Department of Computer Science

So far, this project has produced one technical report, one conference abstract, one local conference paper and one journal paper that won a best paper award. The project also won the first Ames Laboratory award for Computational Science Education in 1994.

C.A. Shaffer, L.W. Carstensen, Jr., V.F. Miranda, S.K. Kriss, R.W. Morrill, and E.A. Fox, **Project GeoSim**: the first two modules, Computer Science TR 91-26, VPI&SU, Oct 1991.

C.A. Shaffer, V. Miranda, J.J.C. Wang, S. Kriss, L.W. Carstensen, Jr., R.W. Morrill, and E.A. Fox. "Computerized simulations for introductory geography instruction", *Proceedings of Application of Geographic Information Systems, Simulation Models, and Knowledge-based Systems for Landuse Management*, Blacksburg, VA, Nov 12-14, 1990, 479-480.

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J.M.A. Begole and C.A. Shaffer, The **Project GeoSim** graphical user interface, *Proceedings of the 23rd Virginia Computer User's Conference*, October 1993, 17-28.

L.W. Carstensen, Jr., C.A. Shaffer, R.W. Morrill and E.A. Fox. **GeoSim**: A GIS-based simulation laboratory for introductory geography, *Journal of Geography 92*, 5(Sep/Oct 1993), 217-222.

Presentations and demonstrations of our software have been made at the following meetings and conferences:

National Council for Geographic Education Annual Meeting, St. Paul, MN, October 1991.

FIPSE Project Directors' Meeting, Washington D.C., October 1992.

Center for Talented Youth Environment Day, Virginia Tech. October 1992.

Southeastern Division of the Association of American Geographers Annual Meeting, Louisville, KY, November 1992.

Association of American Geographers Annual Meeting. Atlanta, GA, April 1993.

Center for Talented Youth Environment Day, Virginia Tech. October 1993.

Southeastern Division of the Association of American Geographers Annual Meeting, Greensboro, NC, November 1993.

Upcoming Presentation Commitments:

The ADCIS Conference, February 1994.

Association of American Geographers Annual Meeting, San Francisco, CA, April 1994.

National Council for Geographic Education Annual Meeting, Lexington, KY, October 1994.

Southeastern Division of the Association of American Geographers Annual Meeting, Virginia Beach, VA, November 1994.

All software products from this project are available through the Internet at URL `http://geosim.cs.vt.edu`.

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2 Executive Summary

Project GeoSim:
A GIS-Based Simulation Laboratory for Introductory Geography

Project Director:
Clifford A. Shaffer
Department of Computer Science
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Telephone: 540-231-4354
Email: shaffer@cs.vt.edu

Project Overview: Our goal is to improve geography education through the use of interactive educational software. We developed a number of software modules for use as classroom lecture aides and as standalone lab exercises. In addition to evaluating the use of this software in a traditional introductory geography course at two universities, we experimented with dissemination of software through the Internet. As a result, many educators were made aware of our project, and a number of schools have adopted it.

Purpose: Traditionally, introductory geography has been taught in a lecture and examination format. For many disciplines this format is effective, as the narrative is a major means of communication. Geography is largely a study of process, which must be observered rather than described. Advanced hands-on courses as Remote Sensing and GIS attest to the enthusiasm students feel for applying geography to real problems. Yet, these courses are usually offered only to relatively few advanced students. Computer technologies offer the opportunity to allow students to experience active use of geographic theory and processes through simulation. These processes apply to a wide range of scientific and engineering disciplines.

Background and Origins: Collegiate level introductory geography is often taught to large sections (Virginia Tech is typical with 60-200 students) making individual contact with students difficult. However, Virginia Tech is fortunate to have a wide range of computing facilities. In particular, the Department of Geography maintains a computer lab of roughly 20 IBM-PC compatible computers. This provides enough machines that all students in an introductory class can spend a few hours a week in the computer lab.

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Project Description: The primary activity of our project is to develop and disseminate software for classroom use. Five software modules were eventually produced, along with a development environment for developing educational simulations. Dissemination is primarily via anonymous FTP from `geosim.cs.vt.edu`, or from WWW browsers at the following URL:

`http://geosim.cs.vt.edu`.

Each of the five **GeoSim** modules includes a multimedia Authorware tutorial (for the Mac and PC versions) and an interactive simulation (for all versions). The following five modules are now distributed as part of **Project GeoSim**.

1. **Intlpop/Humpop** teaches the basics of demographics and population modeling.
2. **MigModel** allows student to study modeling of migration patterns between counties of the US. It allows students to select several variables from a larger list that the student hypothesizes affect migration patterns. The patterns that would result if the hypothesis were true are compared against the actual migration patterns to determine the level of correlation.
3. **Mental Maps** is a simple test of knowledge regarding the location and other attributes for cities. Students place selected cities within the outline of the selected country, and may answer questions about average temperature, population and cost of living. Rather than merely a drill exercise, this module is most effective as an information gathering tool regarding students' perceptions about places, to be further discussed in a classroom setting.
4. **Migration and Political Power** simulates the effects of immigration and between-state migration in the United States. It shows how changes in population shift political power through the re-apportionment of seats in the House of Representatives.
5. **Sense of Place** allows students to investigate a large database of information about the counties of the United States. Students may rank counties by multiple criteria, and may view comparative information about counties in map, graph or spreadsheet views.

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Evaluation/Project Results: Evaluation was performed on all modules in classes both at Virginia Tech and at Radford University. For each study topic, a test was prepared. The test classes were broken into separate groups. Depending on the module, some students used only the computer software, some attended only lecture. The test results from both treatments were roughly equivalent, demonstrating that the software performs equally well with respect to the test instrument. A control group of students not taking the class indicated that significant learning took place by both test groups.

Part of our goal was to test the feasibility of disseminating courseware via the Internet and the World Wide Web. During the course of a two year period, users from over 25,000 machines visited our WWW site. Approximate 300 individuals requested to be on our email list. Approximately 30-40 sites have notified us that they have or are about to use the software in their courses. There is no way to tell how many additional sites are using the software.

Summary and Conclusions: Developing good educational simulations requires good software, a good topic, and attention to real-world constraints. We began work on three modules in addition to the ones that were completed as part of the project. In one case, we were attempting to develop for a computing system that would never gain widespread acceptance (Intel's Digital Video Interactive) and so abandoned that project. A second module looked to have a promising simulation, but was pedagogically unsound since the students would have little interaction. Again we abandoned that project to concentrate on a series of modules that would teach the students through significant interaction. The five modules that make up the final complement of **Project GeoSim** are all highly interactive, engaging to the students, and are sufficiently flexible to be used in a variety of classroom activities.

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3 Project Overview

Project GeoSim is a multidisciplinary effort by members of Virginia Tech's Departments of Geography and Computer Science, College of Education, and Learning Resources Center to develop computer-aided education (CAE) software for introductory geography and related classes. Our goal is to improve geography education through the use of interactive educational software. We developed a number of software modules for use as classroom lecture aides and as standalone lab exercises. In addition to evaluating the use of this software in a traditional introductory geography course at two universities, we experimented with dissemination of software through the Internet. As a result, many educators were made aware of our project, and a number of schools have adopted it.

4 Purpose

Traditionally, introductory geography has been taught in a lecture and examination format. For many disciplines this format is effective, as the narrative is a major means of communication. Geography is largely a study of process, which must be observered rather than described. Advanced hands-on courses as Remote Sensing and GIS attest to the enthusiasm students feel for applying geography to real problems. Yet, these courses are usually offered only to relatively few advanced students. Computer technologies offer the opportunity to allow students to experience active use of geographic theory and processes through simulation. These processes apply to a wide range of scientific and engineering disciplines.

5 Background and Origins

Geography is unique among disciplines in its focus on the spatial aspects of physical processes and human actions. Understanding historical and contemporary events requires knowledge of the significance of location; the origins and development of places; consequences of the interactions between humans and the natural environment; interdependence in the movement of goods, people, and ideas on the earth's surface; and the formation and evolution of various types of regions. Yet, dozens of studies point out the incompetence of students in the United States in geography, partially due to a lack of geographic offerings at the primary and secondary levels, and partially due to the dry nature of traditional teaching methods in the field. To

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combat this problem, the Bush Administration released "America 2000: An Education Strategy" which included a call for "challenging subject matter" in geography.

Despite the recognition of the need for improved geography education, geographical instruction is still far behind many other sciences in both universities and secondary schools. **GeoSim** team member Robert W. Morrill has been extremely active and visible in this resurgence. In 1984, *Guidelines for Geographic Education* was published by a joint committee including Dr. Morrill They provide the model for curriculum development and teacher training. Specifically, the *Guidelines* outline five fundamental themes appropriate for inclusion throughout curricula. The themes are

1. Location: Position on the Earth's Surface,
2. Place: Physical and Human Characteristics,
3. Relationships Within Places: Humans and Environments,
4. Movement: Humans Interacting on the Earth,
5. Regions: How They Form and Change.

Internationally, there is widespread adoption of the five themes as a framework for organizing, developing, and implementing geography curricula in K-12 schools. University courses which incorporate and extend the themes provide an effective transition from pre-collegiate curricula to university curricula.

Traditionally, introductory geography has been taught in a lecture and examination format. For many disciplines this format is effective, as the narrative is a major means of communication. Geography can be described, but is much more enticing when experienced through in-depth interaction with the material itself. Popularity of techniques courses such as Remote Sensing and GIS attests to the enthusiasm students feel for applying geography to real problems. Yet, these courses are usually offered only to relatively few advanced students.

To complicate matters further, collegiate level introductory geography is taught to large sections (Virginia Tech is typical with 60-200 students) making individual contact with students difficult. Computer technologies such as **GeoSim** can lessen the burden on instructors via computer administered material reinforced by a hands-on learning activity. Yet geographic software has tended to focus on basic concepts and rote learning rather than

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on geography's systematic approaches to studying world problems. Systematic approaches offer the most interesting interactions between geographic theory and introductory students.

Active use of geographic theory and processes raise general knowledge, not only of the world, but also of the valuable science of geography – both in itself and as an important component of other sciences and engineering. Studies of seed propagation undertaken by biologists indicate distinct geographic patterns based on diffusion, transport, and climate. Geologists study landforms and structures and produce maps, as do geographers. Astronomers map the heavens. Electrical engineers study the propagation of radio and microwaves across geographic regions. Civil engineers model traffic flows along highways, and wildlife biologists study habitats by relating forest cover, food sources, and other spatial variables. Studies of the effects of deforestation on global climate by atmospheric scientists and physicists cannot be accomplished, nor can their meaning be appreciated by society, without a knowledge of geography. The proposed modules illustrate techniques actually used by professional geographers and other scientists to model problems. Tying sophisticated analysis and simulation to the five fundamental themes through relevant exercises enables students to explore the field in manners not previously possible.

Due to the complexity of most available GIS, geographic data handling and analysis are currently reserved for technically-oriented courses at the advanced college level. Yet, through a multidisciplinary approach (geographers in concert with computer scientists and education specialists) aimed solely at educational needs, it is possible to automate the use of GIS so a full understanding of analysis techniques is not a prerequisite to learning from them. In this manner, the most exciting aspects of the spatial science of geography will be made available to a potential audience of 425,000 introductory geography students per year.

6 Project Description

The primary activity of our project was developing and disseminating software for classroom use. Flexible computerized tutorials based on text and graphics have become well established and computerized simulations clearly have great potential. **GeoSim** modules take advantage of the synergy created by using the simulation as an aid to the tutorial presentation. For example, our tutorial on population dynamics makes use of the international population simulator to illustrate points.

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GeoSim tutorials are multi-faceted. Each module assumes that the user has little or no background in the subject matter of the module, use of the controlling computer, or use of the module.

Five software modules were produced for this project, along with a development environment for developing educational simulations. Dissemination is primarily via anonymous from geosim.cs.vt.edu and WWW browsers from URL `http://geosim.cs.vt.edu`.

Our first module, Intlpop/Humpop teaches the basics of demographics and population modeling. Intlpop is an interactive simulation and Humpop is a multimedia tutorial on population issues.

MigModel is a tutorial and simulation for studying modeling of migration patterns between counties of the US. This program allows students to select several variables from a larger list that the student hypothesizes affect migration patterns. The patterns that would result if the hypothesis were true are compared against the actual migration patterns to determine the level of correlation.

Mental Maps (mmap) is a simple test of knowledge regarding the location and other attributes for cities. In the US version, students place selected cities within the outline of the US, and may answer questions about average temperature, population and cost of living. Rather than merely a drill exercise, this module is most effective as an information gathering tool regarding students' perceptions about places, to be further discussed in a classroom setting.

Migration and Political Power (migpol) is a tutorial and simulation of the effects of immigration and between-state migration in the United States. This simulation shows how changes in population shift political power through the re-apportionment of seats in the House of Representatives.

Sense of Place (snsplace) allows students to investigate a large database of information about the counties of the United States. Students may rank counties by multiple criteria, and may view comparative information about counties in map, graph or spreadsheet views.

7 Evaluation/Project Results

Evaluation was accomplished with only a few modifications of the original proposal. All modules have been tested in classes at Virginia Tech and four at Radford University. Professor Robert W. Morrill performed all testing at Virginia Tech, and Professor Lori Barfield performed parallel testing at

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Radford University during the fall semester of 1994.

Testing Procedures: Beginning in January, 1993 the Human Population module was used in classes at Virginia Tech. Initially, formative evaluation was run to look for inconsistencies or errors in the material presented in the tutorials, and for errors or difficulties in running the simulation. Eighteen students from a class taught by Professor Gerard Toal were solicited to run the module. After their feedback, the module was revised and by early March, the final Human Population module was readied for in-class testing.

An exercise was prepared by Professors Morrill and Carstensen. The exercise induced the students to examine both the tutorial and the simulation information, by requiring them to answer questions about world population (see appendix A). To assure full use of the module's navigation tools, questions were not posed in any obvious program sequence, that is, the answer to question Number 2 was not necessarily near the answer to question Number 1 while running through the tutorial and simulation. The exercise was designed to take the equivalent of three class periods (3 hours, 45 minutes, equivalent to one and a half weeks) to complete.

Robert Morrill's introductory geography class, not previously aware of the nature or even the existence of **GeoSim** modules, was split into two approximately equal halves. One half of the class (the lecture group) attended the usual three 75 minute lectures on population geography. The other half (the computer group) signed up for lab time to work on the computer exercise. They viewed the multimedia tutorial and worked through the exercise, projecting population in different parts of the world using the simulation. All students had access to the class textbook, but the computer group did not attend any lectures. In collaboration with Norm Dodl of the Virginia Tech College of Education, an examination was carefully prepared. This test was administered to the entire class and the scores analyzed to determine the effectiveness of the two teaching strategies. In addition, the test was given to another introductory geography class which had not dealt at all with population issues. This class served as the control group for all testing at both Virginia Tech and at Radford.

Each **GeoSim** module has undergone the same summative testing format as that of the Human Population module. An introductory class was split into two sections, one attending lecture, the other working with a computer-based module. Because of the nature of the modules, some tests were run for only two class periods and some for three. In the final semester of testing, classes were exposed to all modules during the course of the

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semester. In these cases, computer groups traded places with lecture groups on alternate modules.

A final aspect of the evaluation for each module was the administration of a questionnaire to the computer group students. This questionnaire requested information on computer experience and ability, the ease of use of the **GeoSim** system, enjoyment and satisfaction with the system, time taken to complete the assignment, whether or not their time was well spent in learning geography in this manner, and a space for general comments (see appendix A for the complete Human Population exercise).

Results: In general the results of the testing at Virginia Tech can be described as most encouraging. Every test of the Human Population module showed that learning had occurred when test scores were compared with those of the control group for both lecture and computer groups. Tests for every module showed that the learning accomplished by the lecture and computer groups was not significantly different when comparing their test scores. It is evident that students can learn geography content from a **GeoSim** module as effectively as attending classes on that same content. This finding has implications for restructuring time spent in lecture settings, for offering certain material in distance learning settings, and for offering material without an instructor's presence. Further, with the Internet distribution system used by **Project GeoSim**, students can learn this material at any location in the world that has access to the computer network.

During the fall semester of 1994, Lori Barfield of the Department of Geography at Radford University used four **GeoSim** modules in her introductory geography class. The methodology described above (splitting the class into halves with a lecture and a computer group) was followed exactly. Professor Barfield used the modules on Human Population (tutorial and simulation), Maps and Mapping (tutorial and simulation), Migration Modeling (tutorial and simulation) and Migration and Sense of Place (tutorial only).

The computer lab available for her use was networked and shared with many other users. She and the students experienced serious difficulties with the computer server. The simulation portions of the modules tended to run slowly as did the graphics in the tutorial sections. This was frustrating to the students and hindered the research process by making it difficult to compare the Radford students' questionnaire information (see Appendix A) with that of the Virginia Tech students. Nevertheless, examination results from the Radford group were similar to those of the Virginia Tech students.

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There were no significant differences between the lecture groups and the computer groups in their test scores. A majority of the Radford students enjoyed the computer modules even though they experienced difficulties in getting them to run smoothly.

One indicator of success in another environment is that Professor Barfield followed up in spring semester 1995 with use of the Human Population Module in two small sections of Introduction to Human Geography. These sections were able to use individual PCs and the module worked fine. Also, Professor Barfield demonstrated the modules to four other geography instructors at Radford and one now uses the Human Population module in a course on population geography.

A final note on evaluation is also significant. The tests conducted are for use of **GeoSim** modules as stand alone teaching tools. It is reasonable to assume therefore that under other use conditions (homework or laboratory assignments in conjunction with lectures) that even better results could be found. (These different scenarios are being used in the introductory geography classes beginning in the fall of 1995). **GeoSim** will be useful as an in-class lecture aid when used with a computer driven overhead LCD panel or in a lab setting with individual machines for each student.

Specific results for each test, along with the questionnaires, are presented in the appendix.

8 Summary and Conclusions

Developing Modules Developing good educational simulations requires good software, a good topic, and attention to real-world constraints. We began work on three modules in addition to the ones that were completed as part of the project. In one case (Orienteering), we were attempting to develop for a computing system that we realized would never gain widespread acceptance (Intel's Digital Video Interactive) and so abandoned that project. A second module (Nuclear Accident) looked to have a promising simulation, but was pedagogically unsound since the students would have little interaction. Again we abandoned that project to concentrate on a series of modules that would teach the students through significant interaction.

On the other hand, we were able to extend our original ideas on migration into three modules. The first, Migration Modeling, focused on creating and testing models. The second, Migration and Political Power, allows students to use a model to explore possible future events (the effects of migration within the U.S. on congressional representation). The third, Sense of Place,

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allows for exploration of a rich database of information on U.S. counties. Each of these modules are sufficiently flexible to be used in a number of classroom settings, and sufficiently interactive and interesting to gain the students' attention.

Dissemination **GeoSim** was conceived back in the dark ages of networking (circa 1990). We originally proposed disseminating of our software by creating a CD-ROM and distributing that to interested parties. The advent of practical access to the World Wide Web through standard browsers such as Mosaic and then NetScape, combined with widespread interest in and access to the Internet by educational institutions at all levels, changed everything. We quickly realized that the best way to distribute our software is to provide free access to it through the Internet.

Internet distribution has proven to be a successful approach. A few statistics help to illustrate this. During the two year period between February 1994 and February 1996, our WWW site was accessed by users of over 25,000 separate machines. Unfortunately, this tells us nothing about how many people have downloaded our software, or how many have used it in a class. As a more direct measure of interest, we note that over 300 people have requested be on our email list announcing updates and new modules. We have also received dozens of other inquiries about our software.

In late 1995, we conducted a survey of the (approximately) 200 people on the email list at that time. We asked questions about how many had used the software, and whether they had used it in classes. Approximately one third of the members of the mailing list returned the survey. From this, approximately 30 sites confirmed that they actually have used the software in one or more classes, or else specified when and how they would use it in the near future. We have also received several messages from many places in the U.S. and in various parts of the world saying that they do use the software, though we have not quantified this response. In the past few months, the number of email messages expressing interest in our software has been growing steadily.

From the above, we feel that it is safe to conclude that

1. Internet dissemination of free courseware is a viable option.
2. **GeoSim** software is known about and used at many sites, with about 30-40 directly reported to us and an unknown number that we have not heard from.

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Future Plans As mentioned above, our means of dissemination is via the Internet and the World Wide Web. We are committed to maintaining the **GeoSim** web site into the forseeable future.

GeoSim was our first major effort in the field of instructional software. As a result of this project, our interests have continued and broadened, and some of the materials developed as part of **GeoSim** are being used for other projects. We list four ongoing projects here.

GIL for introductory Computer Science Education: To support the portability of **GeoSim** modules, we developed **GIL**, the **GeoSim** Interface Library. This is a simple to use library of basic user interface functions that runs under DOS, MacOS and X Windows. We found it so easy to use that we thought it would be useful for beginning programmers in our Computer Science classes. We receive a small grant from the National Science Foundation to pursue this idea. In Spring 1996 our first class of students is successfully using **GIL** to do their introductory computer programs. This gives them practical experience with developing graphical user interfaces at an early stage in their careers.

Swan: A data structure visualization system: Swan is being developed as part of our NSF Educational Infrastructure grant. The goal is to create an easy-to-use system for annotating programs to visualize the underlying data structures. Current data structure visualization systems, while having more capability, are hard to learn and use. Our goal is to create something that typical Computer Science instructors and students can use themselves. Thus, instructors can create illustrations of algorithms to help their class understand the process, and students can use visualization as a "visual debugging" aide. For the sake of portability, Swan was built using **GIL**.

Statistics for the Social Sciences: We are currently seeking support from FIPSE and NSF for a new instructional courseware initiative. Faculty from the Social Sciences and Computer Science will produce computerized course materials that promote understanding and appreciation of statistics and mathematical models among undergraduate students in the social sciences. Our goal is to integrate statistical methods throughout the curricula, rather than isolate student contact with statistics to one or two courses as is common today. This will help students understand the role of statistics in the evaluation of hypotheses, and help students apply analytical thinking skills to claims of fact presented to them in their everyday lives. We will create an integrated courseware package including significant social science databases, visualization and analysis tools, and multimedia tutorials on statistical techniques and the role of models. The courseware will be flexible in

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that it will contain data suitable for use in a broad range of courses in the social sciences, and also allow students to import their own data. It will allow instructors to demonstrate particular statistical techniques or use those techniques to present information relevant to that class. Our courseware will also form a vehicle for integrating statistical material across courses within departments, and across departments within the University. This project builds on **Project GeoSim** by making use of lessons learned in developing simulations and instructional courseware. In particular, the visualization techniques developed as part of the Sense of Place module will form the basis of the database browser for the new project.

Leveraging Networks for Collaborative Education in the Blacksburg Electronic Village: Supported by a major grant from the NSF NIE program. As part of the Blacksburg Electronic Village, several K12 schools in Montgomery County, VA, have T1 links to the Internet. We are trying to take advantage of this basic infrastructure in new ways. We are working to create and evaluate an infrastructure for constructing and conducting experiments in a virtual laboratory. Our architecture will integrate existing and future Internet technology to support collaborative, highly interactive educational settings. Our prototype testbed will address physical science middle and high school students. Our implementation approach is to marry basic capabilities of graphical MUD/MOO technology to support collaborative groups with courseware such as that produced by Project **GeoSim** to create collaborative, interactive, discovery-based virtual learning environments.

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9 Appendix

Human Population: Tutorial and Simulation

The Human Population Tutorial and Simulation were used in Geography 1004 during spring semester 1993, fall semester 1993 and spring semester 1994. Figures 1 and 2 display the results of tests and questionnaires completed by the computer groups participating in those semesters. The research procedure divided the classes by random selection into lecture groups and computer groups.

A majority of students indicated that they were average or experienced computer users, 25 reported being novice users and 5 said they never or almost never used computers. Only two persons reported no experience using a mouse. Most participants found the module easy to use or that it could be used with little effort. Time well spent rankings were on a scale of I-10 and were 7.9, 7.2 and 7.6 respectively indicating satisfaction with the module.

During the treatment of population geography the lecture groups were in class for 3 hours and 45 minutes , whereas the computer groups used 2 hours and 30 minutes, 2 hours and 1 minute, and 2 hours and 9 minutes respectively to complete the lab exercise. Test results on the 32 population questions ranged from 26.36 to 26.88 correct, nearly identical for lecture and computer groups in all three semesters. Overall test scores also showed little variation over the three semesters.

During spring semester 1995, geography graduate student Elizabeth Noble elected to conduct research on the Human Population Module as her thesis. In consultation with geography faculty, Norman Dodl (College of Education) and Robert Frary (Test Scoring Center) she developed population related questions of varying difficulty to determine if computer module users would score higher on difficult questions than the lecture group. Preliminary results indicated that the computer group and the lecture group achieved at the same level with no significant differences on the population geography questions. Further analysis of the results is proceeding as part of Ms. Noble's thesis.

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FIGURE 1

HUMAN POPULATION

TUTORIAL AND SIMULATION

INTRODUCTION TO HUMAN GEOGRAPHY 1004

SPRING 1993		FALL 1993		SPRING 1994	
LECTURE	*COMPUTER*	*LECTURE*	*COMPUTER*	*LECTURE*	*COMPUTER*
N=25	N=26	N=51	N =32	N=39	N=37
TIME USED					
3H 45M	2H 30M	3H 45M	2H 1M	3H 45M	2H 9M
TEST SCORES					
32 QUESTIONS ON POPULATION					
26.84	26.36	26.88	26.48	26.33	26.46
WHOLE TEST					
56 QUESTIONS		59 QUESTIONS		85 QUESTIONS	
47.16	46.44	47.82	47.17	62.33	63.41

IN SPRING 1993, A MEAN TEST SCORE 17.47 0N A TEST OF 32 QUESTIONS ON POPULATION WAS ACHIEVED BY A SECTION OF GEOGRAPHY 1004 (N=70) WHICH RECEIVED NO INSTRUCTION IN POPULATION GEOGRAPHY.

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FIGURE 2

HUMAN POPULATION

TUTORIAL AND SIMULATION

INTRODUCTION TO HUMAN GEOGRAPHY 1004

EXPERIENCE USING COMPUTERS	**SP93**	**FA93**	**SP94**
A. NEVER OR ALMOST NEVER	3	1	1
B. NOVICE USER	8	9	7
C. AVERAGE USER	11	13	21
D. EXPERIENCED USER	4	8	8
EXPERIENCE USING A MOUSE			
A. NONE	1	1	0
B. A FEW TIMES	10	6	7
C. MANY TIMES	15	24	30
MODULE EASY TO USE ?			
A. NO	0	0	0
B. WITH SOME EFFORT	8	6	5
C. WITH LITTLE EFFORT	13	10	14
D. EASY TO USE	5	15	18

WAS YOUR **TIME WELL SPENT** LEARNING ABOUT HUMAN POPULATION CHANGE IN THIS MANNER?(1 FOR NOT WORTHWHILE AND 10 FOR VERY WORTHWHILE)

SP93	**FA93**	**SP94**
7.9	**7.2**	**7.6**

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Map and Mapping: Tutorial and Simulation

The Maps and Mapping tutorial and simulation were used in two sections of Introduction to Human Geography 1004 during fall semester 1994. Figures 3 and 4 provide summaries of the results. The established research procedures were followed. Both computer groups had majorities of students who identified themselves as average to experienced computer users, only one student had not previously used a mouse, and all students found the module relatively easy to use. On a scale of 1-10 the students in the 9:00 AM computer group scored the module at 8.1 in terms of time well spent and the 1:00 PM group scored the module at 8.0 on this question.

Comparisons of time used revealed that the lecture groups were in class for 2 hours and 30 minutes while the computer groups used 1 hour and 53 minutes and 1 hour and 54 minutes respectively. The lecture groups and computer groups in both classes were given the same test questions and their scores were essentially the same. There was no significant difference between the lecture groups and the computer groups on the 15 questions dealing with maps nor on the 66 questions of the entire test.

The test results indicate that on the concepts and information treated in class and in the computer modules students learned as effectively using the modules as they did by attending class. Further, the module evaluation survey indicates a high level of satisfaction with the module and its ease of use.

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FIGURE 3

MAPS AND MAPPING

TUTORIAL AND SIMULATION

FALL 1994 INTRODUCTION TO HUMAN GEOGRAPHY 1004

9 AM CLASS		1 PM CLASS	
LECTURE N=37	*COMPUTER* N=43	*LECTURE* N=89	*COMPUTER* N=53
TIME USED			
2H 30M	**1H 53M**	**2H 30M**	**1H 54M**
TEST SCORES			
15 QUESTIONS ON MAPS			
10.84	**11.00**	**11.18**	**11.40**
TEST SCORES			
66 QUESTIONS ON WHOLE TEST			
49.68	**49.51**	**50.45**	**51.26**

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FIGURE 4

MAPS AND MAPPING

TUTORIAL AND SIMULATION

FALL 1994 INTRODUCTION TO HUMAN GEOGRAPHY

TWO SECTIONS TESTED

EXPERIENCE USING COMPUTERS	9 AM CLASS	1 PM CLASS
A. NEVER OR ALMOST NEVER	1	0
B. NOVICE USER	6	16
C. AVERAGE USER	31	33
D. EXPERIENCED USER	5	8
EXPERIENCE USING A MOUSE		
A. NONE	1	0
B. A FEW TIMES	11	10
C. MANY TIMES	31	47
MODULE EASY TO USE ?		
A. NO	0	0
B. WITH SOME EFFORT	0	0
C. WITH LITTLE EFFORT	8	5
D. EASY TO USE	35	52

WAS YOUR **TIME WELL SPENT** LEARNING ABOUT MAPS AND MAPPING IN THIS MANNER?(1 FOR NOT WORTHWHILE AND 10 FOR VERY WORTHWHILE)

8.1 8.O

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Migration and Sense of Place: Tutorial

NOTE: (The simulation portion of the Sense of Place Module was not tested in class since its large data base was incomplete at the time of the testing.)

Students from two sections of Introduction to Human Geography 1004 participated in using the Migration and Sense of Place Tutorial during fall semester 1994. As with other modules, the research procedure required students to complete the module without attending classes. Figures 5 and 6 provide summaries of the results. A majority of students reported that they were average to experienced users of computers, only one indicated no prior use of a mouse. Most reported that the module was easy to use or could be used with little effort. One person stated that the module was not easy to use and 7 thought that the module could be used with some effort. When asked if their time with the module was well spent the two computer groups, using a 1-10 scale, scored the tutorial 6.1 and 6.5 respectively .

The lecture groups spent 1 hour and 40 minutes in class and the computer groups spent 1 hour and 33 minutes and 1 hour and 40 minutes respectively completing their lab exercises. The test contained 10 questions dealing with Migration and Sense of Place and there was essentially no difference between the two lecture groups and the two computer groups either on the 10 questions or on the 79 questions of the entire test..

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FIGURE 5

MIGRATION AND SENSE OF PLACE

TUTORIAL ONLY

FALL 1994 INTRODUCTION TO HUMAN GEOGRAPHY

LECTURE GROUPS		COMPUTER GROUPS	
9:00AM	1:00PM	9:00AM	1:00PM
N=47	N=120	N=26	N=24
TIME USED			
1H 40M	1H 40M	1H 33M	1H 4OM
TEST SCORES 10 QUESTIONS			
7.57	7.76	7.29	7.65
TEST SCORES WHOLE TEST 79 QUESTIONS			
52.04	52.86	52.13	52.48

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FIGURE 6

MIGRATION AND SENSE OF PLACE

TUTORIAL ONLY

FALL 1994 INTRODUCTION TO HUMAN GEOGRAPHY 1004

EXPERIENCE USING COMPUTERS	9 AM CLASS	1 PM CLASS
A. NEVER OR ALMOST NEVER	0	0
B. NOVICE USER	5	4
C. AVERAGE USER	20	15
D. EXPERIENCED USER	1	3
EXPERIENCE USING A MOUSE		
A. NONE	0	1
B. A FEW TIMES	4	1
C. MANY TIMES	22	21
MODULE EASY TO USE ?		
A. NO	1	0
B. WITH SOME EFFORT	4	3
C. WITH LITTLE EFFORT	8	6
D. EASY TO USE	13	52

WAS YOUR **TIME WELL SPENT** LEARNING ABOUT MIGRATION AND SENSE OF PLACE IN THIS MANNER?(1 FOR NOT WORTHWHILE AND 10 FOR VERY WORTHWHILE)

6.1	6.5

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Migration Modeling of the United States: Tutorial and Simulation

Geography 1004 students from one section in spring semester 1994 and two sections from fall semester 1994 participated in testing the Migration Modeling Tutorial and Simulation. A majority reported being average to experienced computer users, 14 called themselves novice users and one claimed to have never or almost never used a computer. Only six said they had no experience using a mouse. All others said that they had used a mouse a few times or many times. Although most stated that the module could be used with little effort or was easy to use, 13 said that the module could be used with some effort and 6 claimed that it was not easy to use. In terms of whether their time was well spent with the module the three groups , using a 1-10 scale, scored the module 6.3, 4.9 and 5.8 respectively.

The lecture groups spent 2 hours and 30 minutes in class with the material on migration modeling while the computer groups spent 2 hours and 14 minutes, 1 hour and 39 minutes and 1 hour and 56 minutes respectively completing the lab assignment. On the 12 test questions dealing with the topic the groups showed no significant differences among their scores. Similarly there were insignificant differences on the scores for the 85 questions of the whole test.

This module received somewhat low ratings for the time well spent question. Our speculation for this finding is that the topic is more theoretical (less concrete) and mathematical than the other modules, and that migration is extremely difficult to model to a high level of accuracy. Students could never really obtain high khat scores for their models and may have felt frustrated with the module. Further research will ascertain the reasons that this module is not as popular with introductory geography students as the other **GeoSim** modules.

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FIGURE 7

MIGRATION MODELING OF THE UNITED STATES

TUTORIAL AND SIMULATION

INTRODUCTION TO HUMAN GEOGRAPHY 1004

SPRING 1994		FALL 1994			
		9:00AM		1:00PM	
LECTURE	*COMPUTER*	*LECTURE*	*COMPUTER*	*LECTURE*	*COMPUTER*
N=37	N=39	N=46	N=27	N=118	N=26
TIME USED					
2H 30M	2H 14M	2H 30M	1H 39M	2H 30M	1H 56M
TEST SCORES					
12 QUESTIONS ON MODELING					
9.68	9.36	9.28	9.55	9.54	9.22
WHOLE TEST					
85 QUESTIONS					
62.33	63.4	52.04	52.13	52.86	52.48

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FIGURE 8

MIGRATION MODELING OF THE UNITED STATES

TUTORIAL AND SIMULATION

INTRODUCTION TO HUMAN GEOGRAPHY 1004

	SPRING 1994	FALL 1994	
		9:00AM	1:00PM
	(N= 38)	(N=27)	(N=26)
EXPERIENCE USING COMPUTERS			
A. NEVER OR ALMOST NEVER	1	0	0
B. NOVICE USER	8	3	3
C. AVERAGE USER	22	21	17
D. EXPERIENCED USER	7	3	3
EXPERIENCE USING A MOUSE			
A. NONE	5	0	1
B. A FEW TIMES	32	3	4
C. MANY TIMES	1	24	18
MODULE EASY TO USE ?			
A. NO	1	3	2
B. WITH SOME EFFORT	5	4	4
C. WITH LITTLE EFFORT	23	9	4
D. EASY TO USE	9	11	12

WAS YOUR **TIME WELL SPENT** LEARNING ABOUT MIGRATION MODELING IN THIS MANNER?(1 FOR NOT WORTHWHILE AND 10 FOR VERY WORTHWHILE)

6.3	4.9	5.8

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APPENDIX A: Sample Exercise and Questionnaire used by the Computer groups in GeoSim evaluation - Appropriate space was given for each response on the original exercise. Spaces have been removed for brevity in this copy.

Human Population Change

Lab Assignment NAME_____

This assignment will be done in the computer laboratory in the department of Geography (room 301-D Patton Hall). When you have completed the entire exercise and answered the evaluation questions on the last page, please turn this in in class when you return. The evaluations may be separated from the assignment for anonymity if you desire to do so.

To begin the software module:

1) All 10 machines are available for your use during the times listed on the sign-up sheet. These machines are located in room 301-D as you enter. Turn on the machine and monitor. Allow it to boot up and follow the instructions to get a DOS prompt on the hard drive [C:\>]

2) Type: WIN (begin MS WINDOWS)

3) Open the **GeoSim** group icon by pointing to it and quickly clicking twice on the left button of the mouse. NOTE: (it may be open as a window if it was left that way by the last user.)

4) Quickly click twice on the HUMPOP icon to begin the program.

It is important to take time to familiarize yourself with all the terms that are defined and explained in the five sections of the tutorial. This entire project is designed to take approximately the equivalent of three class periods (3 hours and 45 minutes), but you may take any amount of time you think is necessary to complete it. Proceed through the human population change tutorial at your own pace using the suggested sequence of study. You may repeat any aspects you need to at any time. As this material may be on the next examination, you will want to make notes in your class notebook on key ideas and terms that are unfamiliar to you.

As you progress through the tutorial and through the simulation, answer the following questions in the spaces provided:

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1) What was the approximate 1990 population of the world?

2) What are four basic needs that must be met in every human population

3) Identify three ways in which human populations modify the physical environment?

4) As human population increases, human-physical environment interactions intensify. Identify three specific consequences of these intensified interactions.

5) What do the bars on a population pyramid represent?

6) Developing countries are usually associated with stages 2+3 of the demographic transition. Describe what is happening with birth rates, death rates, and total population in those stages.

7) Developed countries are usually associated with stage 4 of the demographic transition. Describe what is happening with birth rates, death rates, and total population in that stage.

8) Which continent has the most countries with low life expectancies?

9) In 1990, which country had the highest infant mortality rate?

10) What is the net migration for country A in the illustration provided?

In the simulation, we will first look at population trends around the world, then at more regional and local scales. To enter the simulation begin the tutorial as directed above, then press the "BEGIN SIMULATION" button on the main menu.

Information on running the simulation is available at any time through the HELP button. If at any time you cannot remember the meaning of any term used in this exercise, press the **Glossary** button to return to the tutorial section and look up the term.

Use the map to select the regions or countries below. If you cannot locate the appropriate region or country on the map, then you may resort to the list. Answer the following questions by using the appropriate simulation sequences:

WORLD

1) What was the:

a) 1990 population of the world? _____

b) 1990 Total Fertility Rate? _____

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c) Percent of the world's population in Europe 2040 _____

d) Percent of the world's population in Africa 2040 _____

HAITI - HUNGARY

Compare these two countries on the same screen. Open Haiti in the top window, Hungary in the bottom window:

1) What was the:

a) 1990 population of Haiti? _____

b) 1990 Total Fertility Rate? _____

c) 1990 Life Expectancy? _____

d) Approximate doubling time _____

e) 1990 Infant Mortality Rate _____

2) What was the:

a) 1990 population of Hungary _____

b) 1990 Total Fertility Rate? _____

c) 1990 Life Expectancy? _____

d) Approximate doubling time _____

e) 1990 Infant Mortality Rate _____

3) If 1990 conditions persist, what will Haiti's population be in:

a) the year 2010? _____

b) the year 2040? _____

4) If 1990 conditions persist, what will Hungary's population be in:

a) the year 2010? _____

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b) the year 2040? _____

5) (Use the VIEW BIRTH AND DEATH RATES option) If the infant mortality rate in Haiti were reduced by 50% immediately (1990):

a) What would the Total Fertility Rate become? _____

b) Why?

c) What would the life expectancy become? _____

d) Why?

6) If the women of Haiti had been struck in 1990 by a major epidemic such that approximately 1/3 of those between the ages of 10-19, 20-29, and 30-39 had died (all other factors remain the same as the 1990 conditions), what would the population be in:

a) the year 2010? _____

b) the year 2040? _____

7) (Use the VIEW BIRTH AND DEATH RATES option) In Haiti, if all pregnancies to women under the age of 20 were eliminated, but an equal number were added by women 50-59, what difference would this make in the total population of Haiti in 2040 as opposed to the 1990 conditions you used above (#3)? Give the difference in number of persons and circle fewer or more.

With the change there would be _____ fewer I more people in 2040

Why?

UNITED STATES

1) What was the:

a) 1990 population of the US? _____

b) 1990 Total Fertility Rate? _____

c) 1990 Life Expectancy? _____

2) If 1990 conditions persist, what will the US population be in:

a) the year 2010? _____

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c) 1990 Life Expectancy? _____

2) If 199 conditions persist, what will the population of the world be in:

a) the year 2010? _____

b) the year 2040? _____

3) If total fertility rate had begun to decline to 2.1 (approximately the replacement level) in 1990 completing the change in 2010, what would be the population of the world in the year 2040? [To simulate this change, select the Total Fertility Rate button and adjust the rate to 2.1. Also set the effective year to 2010. Close the window and run the simulation.]

_____

4) What would the world's population be in the year 2040 if, at the same time that the total fertility rate declined worldwide (same as #3 above), life expectancy increased to 68.1 years? Use the same modeling procedure as in #3, that is, begin both changes in 1990 having them complete in 2010.

_____

AFRICA

1) What was the:

a) 1990 population of Africa? _____

b) 1990 Total Fertility Rate? _____

c) 1990 Life Expectancy? _____

2) If 1990 conditions persist, what will Africa's population be in:

a) the year 2010? _____

b) the year 2040? _____

3) If total fertility rate in Africa had begun to decline to 3.4 (the worldwide rate) in 1990 completing the change in 2010, what would be the population of Africa in the year 2040?

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_____

4) Using the same modeling as for #3 above, what would Africa's population be in the year 2040 if, at the same time that the total fertility rate declined, life expectancy increased to 56.1 years?

_____

EUROPE

1) What was the:

a) 1990 population of Europe? _____

b) 1990 Total Fertility Rate? _____

c) 1990 Life Expectancy? _____

2) If 1990 conditions persist, what will Europe's population be in:

a) the year 2010? _____

b) the year 2040? _____

3) If, due to declining numbers, the governments of Europe developed incentives to increase the total fertility rate to 2.4 with the change beginning in 1990, and gradually increasing to completion in 2010, what would the population of Europe be in the year 2040?

_____

4) Describe (briefly) a particular incentive system you think a government might use to accomplish the increases described in #3 above.

COMPARISON OF AFRICA AND EUROPE

Using your data above for persistence of 1990 conditions and simple division and multiplication (either on paper or a calculator), compute the following population ratios (nearest integer percent):.

a) Percent of the world's population in Europe 1990 _____

b) Percent of the world's population in Africa 1990 _____

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b) the year 2040? _____

3) Note that under 1990 conditions US population growth has begun to level out by the year 2050. Note also the large number of immigrants to the US at present. Note also that the 1990 total fertility rate is slightly below replacement level.

Using the tools available, experiment to develop two different plans by which the US population could achieve ZERO POPULATION GROWTH by the year 2020. (You may use one or more variables simultaneously for each plan.)

For each method, describe your adjustments, and give the peak population level and year achieved.

a) ADJUSTMENT(S) MADE PEAK POP YEAR OF PEAK

b) ADJUSTMENT(S) MADE PEAK POP YEAR OF PEAK

Your reflections on the use of the Human Population Change Module

We **greatly appreciate** your willingness to work with us in evaluating this new teaching approach for introductory geography. As a final request, would you please answer the following questions regarding your experience using this tutorial and simulation program.

How much experience do you have using computers?

a) I have never, or almost never used a computer before.
b) I consider myself a novice computer user.
c) I consider myself an average computer user.
d) I consider myself an experienced computer user.

Have you ever used a computer program operated by a mouse before?

a) no
b) yes, but only a few times
c) yes, many times

Did you find this program easy to use?

a) no, I couldn't understand the controls
b) with some effort I was able to understand the controls
c) I was able to understand most of the controls with a little effort
d) the controls were all easy to understand

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In general, what types of operations did you find difficult?

In general, what types of operations did you find easy?

Was the exercise enjoyable for you (as compared to attending lectures to obtain similar information)? Why?

Do you think that the exercise gave you information more or less effectively than a typical in-class lecture on the same topics? Why?

Do you think that you learned more or less information from this experience than you would have in class? Why?

Do you think that you learned different types of information from this experience than you would have in class? If so, what types and why?

Was your time well spent in learning about human population change in this manner? Please rate your overall experience with the Human Population Change Module **(1 for not worthwhile, 10 for very worthwhile)**

1---2---3---4---5---6---7---8---9---10

To the nearest 15 minutes, how much total time did you spend on the computer exercise (please do not include time spent answering these evaluation questions)

_____ hours _____ minutes

Other comments?:

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A GIS-Based Simulation Laboratory for Introductory Geography

Geography is unique among disciplines in its focus on the spatial aspects of physical processes and human actions. Understanding historical and contemporary events requires knowledge of the significance of location, the origins and development of places, consequences of the interactions between humans and the natural environment, the interdependence in the movement of goods, people, and ideas on the earth's surface, and the formation and evolution of various types of regions. Yet, dozens of studies point out weakness in US students regarding geography.

Many geographic processes are dynamic, and are difficult to demonstrate in a traditional classroom setting using static methods such as chalkboards, maps, and overheads. At the same time, while geography is not a discipline of rote memorization, the large body of facts making up a working knowledge of world geography can be learned only by spending time with and using geographic material. Fortunately, the manipulation of geographic information by computer has been intensively studied, with many models of geographic processes well understood. Computer simulations can be developed to illustrate geographic principles and processes, while simultaneously attracting and holding the attention of students long enough so that they can acquire this basic knowledge.

Members of the Departments of Geography and Computer Science at Virginia Tech have initiated **Project GeoSim** to reverse the current decline in geographic awareness among students and eventually the public at large. We begin by applying the immense capabilities of Computer Assisted Education with those of Geographic Information Systems and Computer Simulation to the teaching of introductory Geography. We make use of these powerful software tools to enrich the student's learning process in ways that have never been used at the introductory level.

Project GeoSim is now making available at no cost a series of self-contained computer modules that serve as lab exercises compatible with introductory geography courses taught in the US. These modules are appropriate for students at both the undergraduate level and in high school classes. Educational goals are based on the widely adopted *Guidelines for Geographic Education* (1984) co-authored by **GeoSim** team member Robert W. Morrill.

GeoSim modules are interactive, allowing students to make decisions and manipulate geographic data in ways that encourage learning while maintaining the student's interest. They are easy to use even by computer novices. The modules run on a wide range of low cost computers currently used in universities and high schools, such as IBM PC compatibles, the Macintosh II, and X-windows systems. The modules relate directly to the students as they illustrate events and processes significant to each student's life.

Cliff Shaffer
Laurence W. Carstensen Jr.
Robert W. Morrill
Edward Fox

Virginia Tech Departments of Geography and Computer Science

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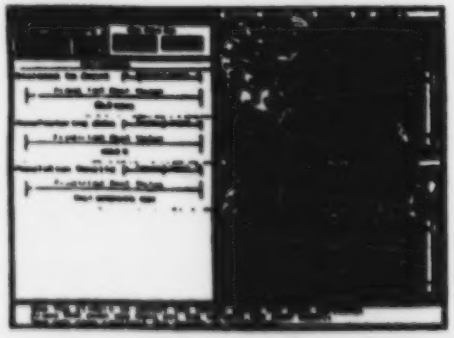
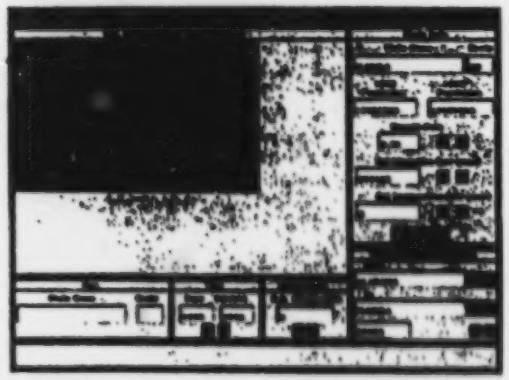
GeoSim modules

Migration Modeling of the United States allows students to study, model, and understand migration patterns at both county and state levels. Students learn about push and pull factors in migration, their social effects, and how the scientific method applies to building models in the social sciences.

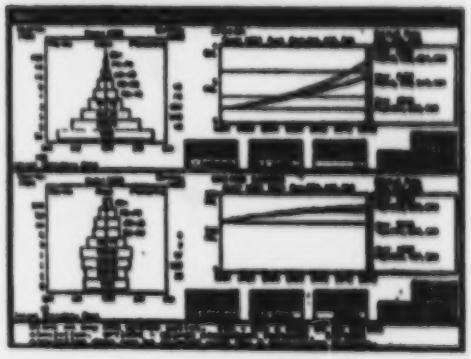


Migration and a Sense of Place aids students in locating places in the United States in which they might someday choose to live. Students select place characteristics (at the county level) that they think would be appealing to them from an extensive database. The program ranks counties of the US according to the degree to which each offers those characteristics. A tutorial on environmental perception illustrates to students the importance that perception plays in both individual and collective spatial behavior.

Migration and Political Power in the United States examines the effects of US migration patterns on national politics, such as presidential elections, and congressional representation.



Human Population allows students to manipulate birth and death rates, life expectancy and migration variables to see the resulting impacts on population growth or decline in any country or region in the world. Hypothesis testing and experimentation illustrate the scientific method.



Maps and Mapping allows students to test their knowledge of location, population, climate and other information for cities around the world. A tutorial on maps and mental maps makes this module a good basic introduction to maps and mapping.

GeoSim software, documentation and sample classroom exercises are available free via anonymous FTP or gopher from:

geosim.cs.vt.edu (IP number 128.173.40.85)

from the world wide web by accessing:

http://geosim.cs.vt.edu

You can contact us by email at
geosim@cs.vt.edu

If you would like to be on our email list and receive news about updates and new programs, just send an email message to the above address.

By paper mail we are reached at:

Project GeoSim
Department of Computer Science
Virginia Tech
Blacksburg, VA 24061-0106

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